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EVALUATION OF DETERGENTS. V. A STUDY OF WASHING PERFORMANCE OF SOME SURFACE ACTIVE MATERIALS AND COMBINED DETERGENT-SANITIZERS

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Cincinnati, Ohio

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EVALUATION OF DETERGENTS

(V) A Study of Washing Performance of Some Surface Active Materials and Combined Detergent-Sanitizers

by

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EVALUATION OF DETERGENTS

(V) A Study of Washing Performance of Some Surface Active Materials and Combined Detergent-Sanitizers*

Quaternary ammonium compounds have been advocated for use as sanitizing agents for restaurant and dairy utensils. It has been claimed that they are compatible with nonionic and most alkaline detergents and that their sterilizing effect is enhanced at high pH. Various manufacturers and distributors of detergents have combined nonionic and/or alkaline detergents with quaternaries and have recommended them as combined detergent-sanitizers.

Previous studies indicated that in general surface active materials improved the washing performance of alkaline detergents (1) even though the same surface active agents were poor detergents. However, certain mixtures of alkaline and surface active materials showed poor washing performance even though they were found to have physical and chemical characteristics resembling those of excellent detergents. In view of the interest in surface active materials and detergent-sanitizers and the paucity of reliable information that would indicate what might be expected of them for dishwashing, a performance test study was made using the technique that has been described in earlier papers (2,3). A study was also made on the effect of the quaternary ammonium compounds on the washing performance of alkaline detergents by this procedure.

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*Presented at the 117th National Meeting of the American Chemical Society, Detroit, Michigan, April 17-19, 1950.

Results of Washing Performance Tests

The washing performance test results obtained on some representative anionic, cationic and nonionic surface active agents and detergent-sanitizers are shown in Table 1. None of the nine detergent-sanitizers which included alkaline and nonionic detergents combined with quaternaries removed more than 3.0 per cent of the soil when used with Cincinnati tap water in concentrations recommended by the manufacturer or, in the absence of such recommendation in 0.3 per cent* solutions. In fact, most of these detergent-sanitizers either removed no soil or showed a soil build-up. Table 1 also shows that neither of the two nonionic surface active agents and only one out of 11 cationics (quaternary ammonium compounds) removed any soil when tested by the performance test on glass. C-9 was the only cationic tested which removed soil by this test. On the other hand, six of the 13 anionic surface active agents removed between 78 and 92 per cent of the soil.

A study of the effect of 100 p.p.m. of different types of surface active agents on the washing performance of 0.3 per cent solutions of five common alkaline detergents was made. The results of these experiments are shown in Figure 1. In these experiments N-1 was the nonionic surface active agent and A-4 was the anionic surface active agent. It will be noted (Table 1) that both of these materials remove little or no soil when used alone. Reference to Figure 1 shows that 100 p.p.m. of the anionic agent increased slightly the washing performance of both trisodium phosphate and sodium hexametaphosphate.

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* Solution of material as supplied by the manufacturer

These were the only two alkaline detergents with which the anionic was combined and tested. The nonionic surface active agent increased the soil removal performance of all of the alkaline detergents. The results obtained were as follows:

Detergent	Percent Soil Removal	
	Alone	With 100 p.p.m. of Nonionic
Trisodium phosphate	90	94
Sodium hexametaphosphate	78	86
Sodium tetrapyrophosphate	81	94
Sodium metasilicate	70	94
Sodium carbonate	43	64

The quaternaries studied in these experiments included alkyl dimethyl benzyl ammonium chloride, para tertiary octyl phenoxyethoxy dimethyl benzyl ammonium chloride, alkyl aryl pyridinium chloride, diisobutyl cresoxy ethyoxy ethyl dimethyl benzyl ammonium chloride, lauryl pyridinium chloride and cetyl dimethyl ethyl ammonium bromide. The results plotted on Figure 1 are the mean data obtained in experiments when 100 p.p.m. of three to five of the above quaternaries were included in the 0.3 per cent washing solutions of the detergents. These data show that 100 p.p.m. of all of these quaternaries greatly reduce the washing performance of the indicated alkaline detergents.

Washing Performance of Alkaline Detergents with Increasing Quantities of Quaternaries

The progressive deterioration of the washing performance as increasing quantities of the quaternaries were added to the alkaline

detergents was determined in another series of experiments. Separate washing performance tests with each of three to five quaternaries added to the alkaline detergents were made. The average washing performance obtained by all quaternaries tested at each concentration with the alkaline detergents was calculated and the results are plotted in Figure 2. As little as 10 p.p.m. of all the quaternaries used materially reduced the washing performance of the alkaline detergents. The data show that the drop in washing efficiency is rapid until 50 p.p.m. of the quaternary are present. Subsequent additions cause proportionally less reduction. A greater reduction in washing efficiency was produced with the poorer detergents (sodium meta silicate and sodium carbonate). The washing performance of sodium hexametaphosphate was affected less than the other compounds by the presence of a quaternary. This material was found to be incompatible with the quaternaries as evidenced by the turbidity and precipitation when distilled water solutions of the two were mixed. Partial incompatibility was found with sodium tetrapyrophosphate and sodium meta silicate mixtures with the quaternaries.

The Effect of Quaternaries on the Washing Performance of Mixed Alkalies and Other Surface Active Agents

A series of experiments were run in which the effect of 50 p.p.m. of a quaternary (C-11) was determined on the washing performance of two alkaline detergents, a nonionic (N-2), an anionic (A-13) and on mixtures of the above compounds. The results of these experiments are plotted in Figure 3 and show that decrease or increase in the percentage

of soil removed when one surface active agent is added to a compound or mixture varies and cannot be predicted from the washing performance of the individual components of the mixture. It will be noted that the 0.3 per cent solution of six of the mixtures (F, H, I, J, K, L) removed substantially the same percentage of soil when no quaternary was present. However, the percentage removal was significantly different in four of these mixtures (F, H, I, J) when 50 p.p.m. of quaternary was added. It is interesting to note that the presence of the anionic surface active agent (A-13) in mixtures K and L apparently neutralizes the reducing effect of the quaternary on the washing efficiency.

By reference to Table 1, it will be noted that one of the cationic detergents, C-9, removed 86 per cent of soil when used in 0.3 per cent solution in Cincinnati tap water. Very similar performances were obtained with 0.1 and 0.2 per cent of this quaternary in tap water (Figure 4). However, when as little as 10 p.p.m. of this cationic was added to TSP to prepare a 0.3 per cent solution combined detergent-sanitizer the washing performance was reduced to 51 per cent soil removal. The results obtained with further addition of this quaternary to TSP are shown in Figure 4. It will be noted, also, that the inclusion of 100 p.p.m. of the quaternary in 0.3 per cent trisodium phosphate reduces the washing performance to that which is obtained with 500 p.p.m. of trisodium phosphate alone.

Summary and Conclusions

Studies were made of the washing performance of alkaline detergents, anionic, nonionic, and cationic surface active agents and mixtures of these materials.

The following conclusions may be drawn from these studies:

(1) The change (increase or decrease) in the washing performance result that is obtained when one surface active agent is added to a detergent compound or mixture cannot be predicted from the performance of the individual components of the mixture.

(2) The addition of small quantities of nonionic and anionic surface active agents, which remove little or no soil when used alone may enhance the washing performance of alkaline detergents.

(3) Of eleven quaternaries studied all except one showed no soil removal from glass when used alone in the performance test. One quaternary showed 86 per cent soil removal in the performance test.

(4) The washing performance of alkaline detergents and of mixtures of such detergents with nonionic surface active agents was decreased by the addition of quaternary compounds, even when as little as 10 p.p.m. of the latter was added.

(5) The washing performance of the detergent-quaternary mixtures was decreased more rapidly as the proportion of quaternary was increased.

References

(1) Norris, Francis I., and Ruchhoft, C. C. "Evaluation of Detergents, A Correlation of Washing Performance with Dissolving and Wetting Ability". Presented at the American Chemical Society meeting in Atlantic City, September 1949. (In Press)

(2) Mann, Edward H. and Ruchhoft, C. C. "A Performance Test for Rating Dishwashing Detergents". Public Health Reports 61, 877-887 (June 14, 1946).

(3) Norris, Francis I., and Ruchhoft, C. C. "Some Improvements in the Performance Test for Dishwashing Detergents". Public Health Reports 63, 97-109 (January 23, 1948).

Table 1

Results of Washing Performance Tests on Various Surface Active Materials and Combined Detergent-Sanitizers

Surface Active Agent	Type	Percent* Soil Removal	Surface Active Agent	Type	Percent* Soil Removal
	Detergent				
DS-1	Sanitizer	0	N-1	Nonionic	-17
DS-2	"	2	N-2	"	-17
DS-3	"	3			
DS-4	"	-8	A-1	Anionic	-8
DS-5	"	-17	A-2	"	-13
DS-6	"	0	A-3	"	-13
DS-7	"	-13	A-4	"	12
DS-8	"	-37	A-5	"	5
DS-9	"	-17	A-6	"	11
			A-7	"	13
C-1	Cationic	-8	A-8	"	82
C-2	"	-17	A-9	"	82
C-3	"	0	A-10	"	78
C-4	"	-8	A-11	"	84
C-5	"	0	A-12	"	88
C-6	"	-8	A-13	"	92
C-7	"	0			
C-8	"	-17			
C-9	"	86			
C-10	"	0			
C-11	"	-33			

* By the concentration recommended by the manufacturer dissolved in Cincinnati tap water or, in the absence of such recommendation, by 0.3 per cent solution.

FIGURE 1

EFFECT OF DIFFERENT TYPES OF SURFACE ACTIVE AGENTS ON WASHING PERFORMANCE OF ALKALINE DETERGENTS

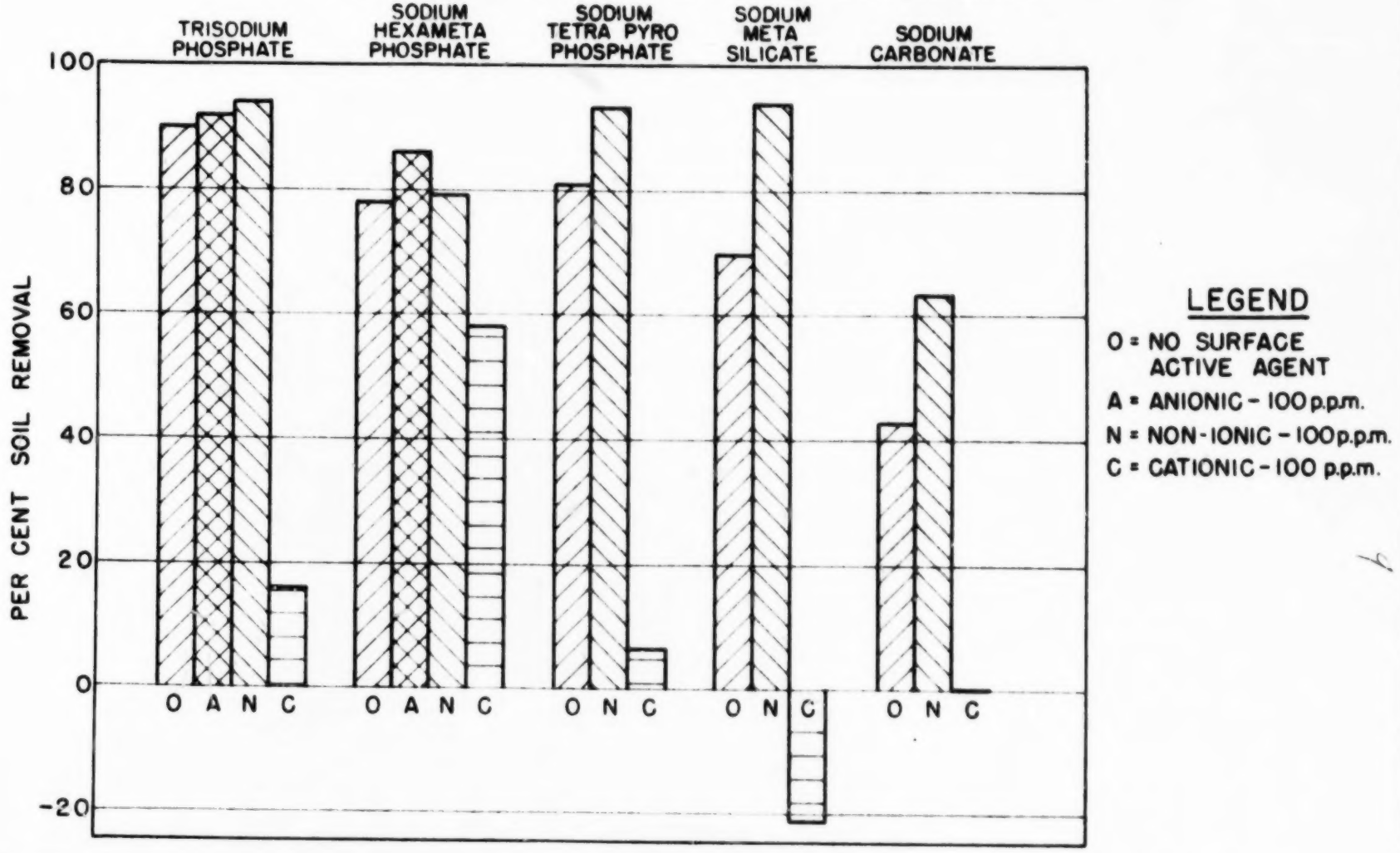


FIGURE 2
WASHING PERFORMANCE OF ALKALINE DETERGENTS
WITH ADDED QUATERNARY COMPOUNDS
(COMPOSITE EFFECT - AVERAGE OF 3-5 Q.A.C.)

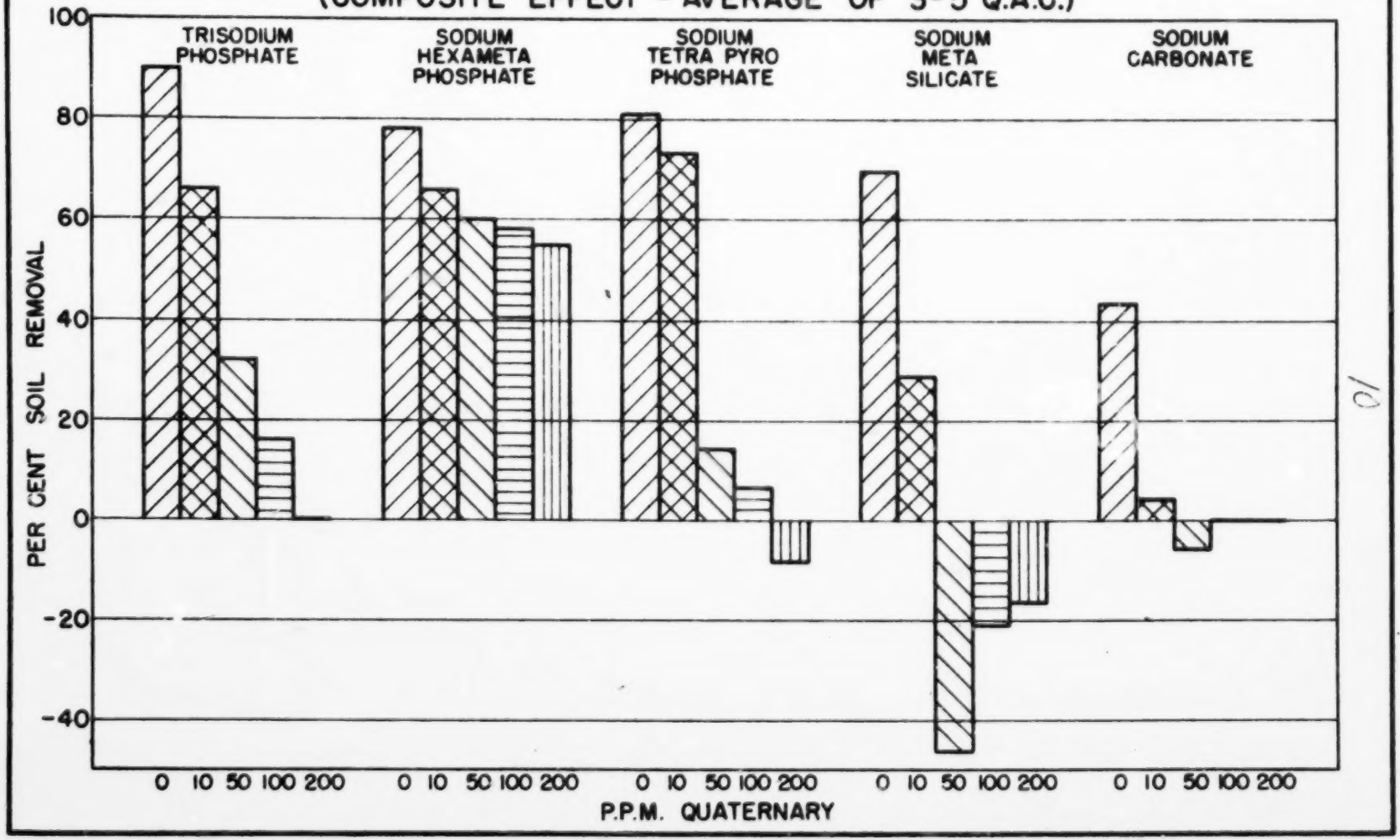
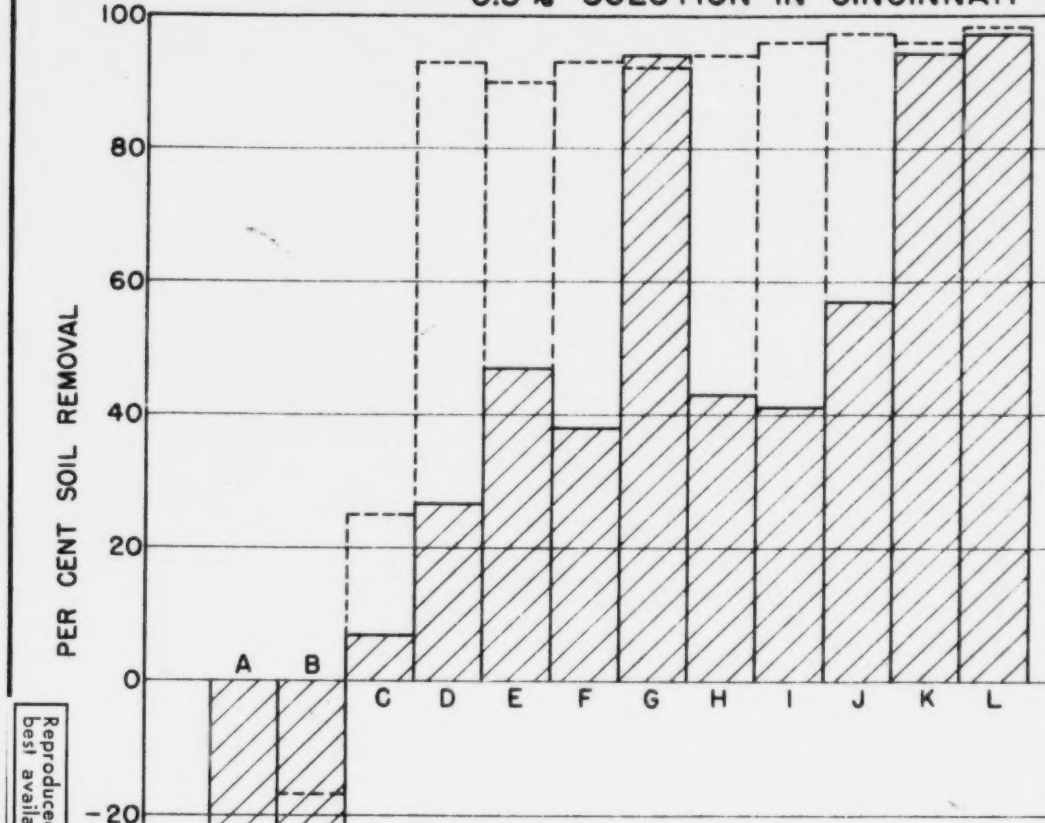


FIGURE 3
EFFECT OF SURFACE ACTIVE AGENTS ON DETERGENCY
0.3% SOLUTION IN CINCINNATI TAP WATER



LEGEND

NO.	PER CENT			
	TSP	TPP	X_1	X_2
A	0	0	0	0
B	0	0	100	0
C	0	0	95	5
D	0	100	0	0
E	100	0	0	0
F	0	95	5	0
G	0	0	0	100
H	95	0	5	0
I	40	60	0	0
J	38	57	5	0
K	0	0	5	95
L	38	57	0	5

Cross Hatch = 50 p.p.m. Quaternary Present
C-11
Dotted = No Quaternary

TSP = Trisodium phosphate
TPP = Tripoly phosphate
X_1 = Nonionic N-2
X_2 = Anionic A-13

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FIGURE 4
WASHING PERFORMANCE OF TRISODIUM PHOSPHATE AND QUATERNARY AND MIXTURES OF THE TWO IN CINCINNATI TAP WATER